United States Patent [19]

May

[11] **3,882,354**

[45] **May 6, 1975**

[54] **INVERTER BALLAST CIRCUIT FOR FLUORESCENT LAMP**

[75] Inventor: **Randall L. May,** Andover, Kans.

[73] Assignee: **The Coleman Company,** Wichita, Kans.

[22] Filed: **July 23, 1973**

[21] Appl. No.: **381,858**

[52] **U.S. Cl.** **315/101;** 315/105; 315/206; 315/221; 315/DIG. 5; 315/DIG. 7

[51] **Int. Cl.** **H05b 41/29;** H05b 41/392

[58] **Field of Search** ..... 315/94–98, 315/101, 105, 200, 206, 221, 278, DIG. 2, DIG. 5, DIG. 7, 177–179, 181; 331/112

[56] **References Cited**

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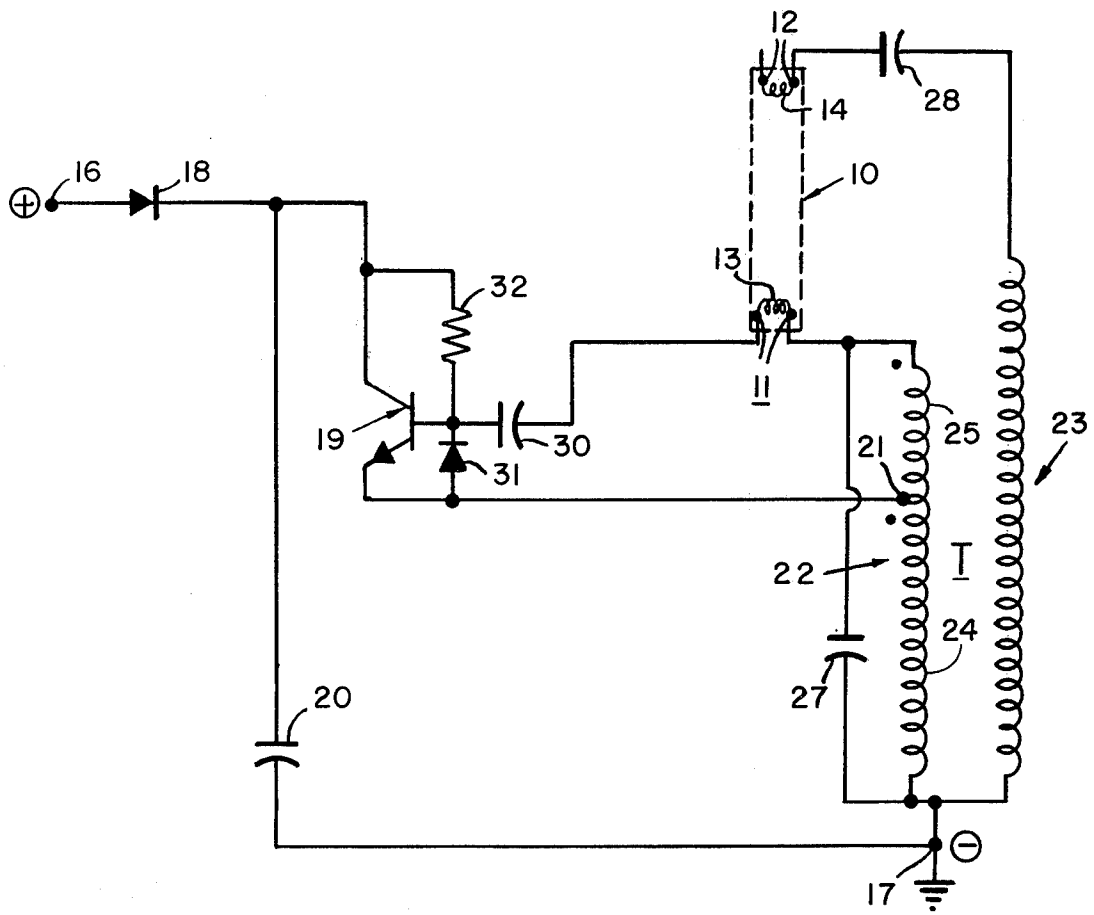
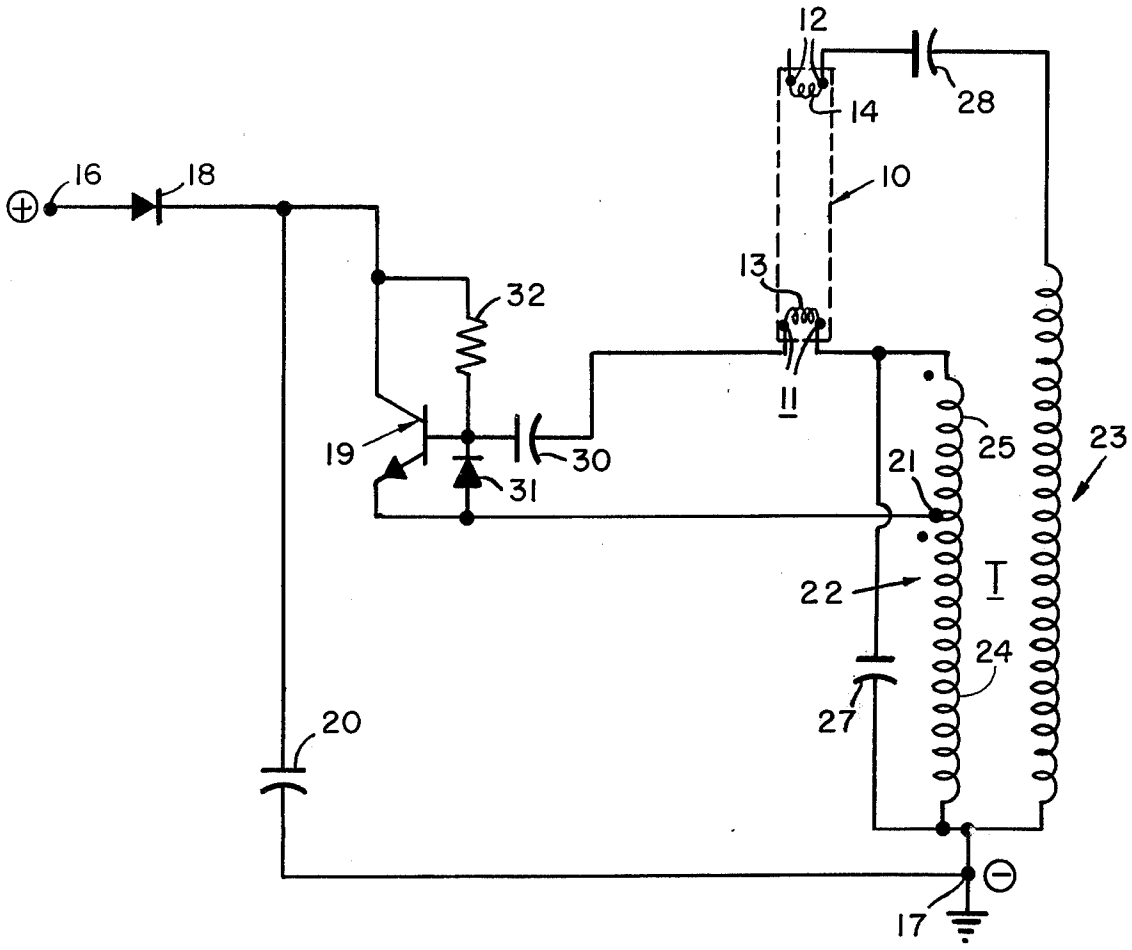
Primary Examiner—R. V. Rolinec
Assistant Examiner—E. R. LaRoche
Attorney, Agent, or Firm—Dawson, Tilton, Fallon & Lungmus

[57] **ABSTRACT**

An oscillator including a single transistor is connected in circuit with the primary winding of a stepup transformer. The terminals of a fluorescent lamp are connected between the primary and secondary of the transformer. One filament of the lamp is connected in the base circuit of the transistor. The filament acts as a constant current device to limit the current flowing in the base circuit and thereby permit the inverter to operate over a wide range of input voltages.

2 Claims, 1 Drawing Figure

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INVERTER BALLAST CIRCUIT FOR FLUORESCENT LAMP

BACKGROUND AND SUMMARY

The present invention relates to an inverter ballast circuit for fluorescent lamps. There are many such circuits already known, and the purpose of these circuits is to convert a D.C. voltage to an alternating voltage of suitable magnitude and frequency to energize a fluorescent lamp.

One of the problems with prior inverter ballast circuit designs is that they do not operate well over a wide range of input D.C. voltages. One of the major uses of inverter ballast circuits is in recreational vehicles; and depending upon the vehicle design and the state or condition of the batteries of the vehicles, an inverter ballast circuit, to be practical, must operate with a range of input voltages extending from 8 or 9 volts up to 25 volts.

The present invention has as a principal object, the design of an inverter ballast circuit for operating fluorescent lamps which is capable of operation over a wide range of input D.C. voltages. The present circuit includes an oscillator having a single transistor as an active element. The transistor is connected in circuit with the primary winding of a step-up transformer. The terminals of a fluorescent lamp are connected between the primary and secondary windings of the transformer.

One filament of the lamp is connected in the base circuit of the transistor, preferably in series between the base terminal of the transistor and one terminal of the primary winding of the transformer. The filament thus acts as a constant current device to limit the gain of the transistor independent of the input voltage source. That is to say, with the filament of the lamp in series with the base circuit of the transistor, if the input voltage is increased, a slight additional average current through the filament will cause it to heat up, thereby increasing its resistance dramatically, and tending to stabilize the base current at a fixed value. Similarly, if the input voltage is decreased, a corresponding slight decrease in the base current will substantially reduce the resistance of the heater filament of the lamp, and thereby permit more base current to flow than would otherwise flow if the resistance of the heater filament were not so temperature dependent.

The light given off by a fluorescent lamp is a linear function of the applied voltage, and for slight changes in applied voltage, the change in light intensity is not very noticeable. Hence, the present invention provides a suitable inverter ballast circuit for fluorescent lamps over a wide range of input voltages.

Another feature of the present invention is that it produces a better starting circuit, especially in cold weather. The reason for this is that when the circuit is first turned on, the filament of the tube is cold, thereby providing a maximum of base current and, hence, a maximum voltage output from the transformer to start the lamp. The filament heats rapidly with a maximum of base current, and this has an advantage in that a tube with a hot filament starts easier than a tube with cold filaments.

Another advantage of the present invention, and one that is considered quite important, is that if the fluorescent lamp is dislodged from its socket, the circuit is shut off--that is, completely prevented from operating--because the base circuit of the transistor is interrupted. In many prior circuits, if the fluorescent lamp fell out of its socket, not only would the inverter circuit continue to operate, but it would generate an excessive voltage because such circuits were designed to produce a high voltage across the tube terminals until the lamp was lit, and the voltage would then drop as the lamp began to conduct. If the lamp did not conduct or became dislodged, the circuits continued to generate an excessively high voltage. Under these circumstances, the circuit also continues to draw excess current which will destroy the transistor and associated circuitry on the inverter.

The present invention also has the advantage that one or more fluorescent lamps can be connected in series with each other and excited by the same inverter ballast circuit. In such an arrangement, a No. 1 lamp would have its filament connected in series with the base circuit of the transistor in the oscillator. Thus, if any single tube goes out, it is simply replaced; but if all of the lamps go out, the No. 1 lamp is replaced because it is known that if the No. 1 lamp burns out, it will inhibit operation of the other lamps because the inverter ballast circuit will not be capable of operating.

Other features and advantages of the present invention wil be apparent to persons skilled in the art from the following detailed description of a preferred embodiment accompanied by the drawing.

THE DRAWING

The single FIGURE is a circuit schematic diagram of an inverter ballast circuit incorporating the present invention.

DETAILED DESCRIPTION

Referring to the drawing, reference numeral **10** generally designates a fluorescent lamp having a pair of terminals **11** at one end and a similar pair of terminals **12** at the other end. A filament **13** is connected between the terminals **11**, and a similar filament **14** is connected between the terminals **12** is not used in the illustrated embodiment.

A source of input D.C. voltage, such as a storage battery, has its positive terminal connected to an input terminal **16** of the circuit, and its negative terminal connected to the circuit terminal **17** which may be ground.

The terminal **16** is connected by means of a diode **18** to the collector of a transistor generally designated **19.** A capacitor is connected from the collector of the transistor **19** to ground.

The emitter of transistor **19** is connected to a terminal **21** of a transformer T which has a primary winding generally designated **22** and a secondary winding **23.** The primary winding **22** includes a first series of turns **24** and a second series of turns **25** connected in series. The terminal **21,** previously mentioned, consists of a tap between the windings **24, 25.**

A capacitor **27** is connected across the entire primary **22,** to suppress transients, and the lamp **10** is connected between the primary and secondary windings, in series with a current limiting capacitor **28.** That is, one of the terminals **11** is connected to the ungrounded terminal of the primary winding **22,** and one of the terminals **12** is connected to the ungrounded terminal of the secondary **23** via capacitor **28.**

The other terminal **11** of the lamp **10** is connected in series with a capacitor **30** to the base terminal of transistor **19.** A diode **31** is connected in the polarity shown

between the base and emitter terminals of the transistor **19**; and a leakage resistor **32** is connected between the base and collector terminals of the transistor **19.**

OPERATION

With the lamp and circuit connected as shown in the drawing, and a source of D.C. voltage connected to the terminals **16, 17** in the polarity shown, the circuit operation will now be described. It will be appreciated that a manually operated switch is normally incorporated into the circuit for turning the lamp on and off, and such a switch may preferably be located in series with the diode **18.**

When power is applied to the transistor **19,** it will be appreciated that the base is biased positively relatively to the emitter, and this will initially cause the transistor to conduct. The resulting current flows through the section **24** of the primary winding **22** of the transformer T. Thus, the terminal **21** will begin to go positive, as will the corresponding dotted terminals of the section **25** of the primary **22** and the secondary winding **23.** When the dotted terminal of the section **25** of the primary **22** goes positive, the transistor **19** becomes more forward biased, thereby resulting in additional emitter current, the final value of which will depend upon the base current which, in turn, is dependent upon the value of resistance in the filament **13.** Initially, the filament **13** is cold, so the initial current energizing transformer T is large, and the secondary voltage is also large, thereby supplying a large voltage to start the tube **10.**

Another way to view this operation is that when the filament **13** is cold, its resistance is low, so the base current is high, thereby reducing the voltage across the collector-emitter terminals of the transistor **19.** Since the input voltage is constant, the remaining voltage appears directly across the section **24** of the primary winding **22.**

As the current flowing in the secondary changes slope polarity, the voltage across the primary section **25** and secondary **23** will also diminish, and the reduced voltage at the primary section **25** will reduce the base corrent in transistor **19.** The oscillations in the secondary will thus drive the transistor, but the magnitude of base current remains substantially constant.

As the temperature of the filament **13** increases, its resistance increases dramatically, thereby reducing the base current until a stable, equilibrium position is reached.

The operation thus far described has been only for the starting and continuous operation of the circuit for a given voltage source. One of the principal features of the present invention is that if the voltage source changes in magnitude, or if the circuit is used with a different voltage source of different magnitude, the ballast circuit readily accommodates itself to the change in input voltage magnitude while supplying the lamp **10** with substantially the same terminal voltage for operation.

For example, if the input voltage across the terminals **16, 17** is reduced, the average current flowing in the filament **13** is correspondingly reduced and this will cause the filament to cool somewhat, thereby decreasing its resistance in a nonlinear fashion so that the resulting decrease in base current is almost negligible. In other words, I have found that the filament of the fluorescent tube, in the circuit illustrated, acts as a substantially constant current source. If the voltage across the terminal **16, 17** increases, the resulting base current increase will raise the temperature of the filament **13,** thereby dramatically increasing its resistance value, and permitting only a negligible increase in base current.

It will also be observed that if the tube **10** becomes dislodged from the circuit, the transistor **19** cannot oscillate because the base circuit is disconnected from the regenerating section **25** of the primary **22** of the transformer T. That is to say, there is nothing to turn the base circuit off and cause it to oscillate.

In the embodiment shown, the ratio of the turns of the windings **22, 25, 23** is as follows: 13/9/250. This turns ratio is useful in energizing a single lamp. When it is desired to use more than one lamp, they may be connected in series and the voltages adjusted accordingly. When such an arrangement is used, only the No. **1** tube has its filament connected in series with the base of the transistor **19,** and the remaining tubes are connected in series. Thus, if any of the tubes other than the No. **1** tube burns out, it is simply replaced, but if the No. **1** tube is burned out, this fact will be made known because none of the tubes will then burn.

Having thus described in detail a preferred embodiment of the present invention, persons skilled in the art will be able to modify certain of the structure which has been illustrated and to substitute equivalent elements for those disclosed while continuing to practice the principle of the invention; and it is, therefore, intended that all such modifications and substitutions be covered as they are embraced within the spirit and scope of the appended claims.

We claim:

1. An inverter ballast circuit for energizing a fluorescent lamp from a source of direct voltage comprising: a transistor having a collector, an emitter and a base terminal, said collector being connected to one terminal of said source; a transformer having a primary winding and a secondary winding, said primary winding including an input section and a feedback section; means for connecting said lamp between said primary and secondary winding; means for connecting said feedback winding section of said transformer in series with a filament of said lamp and with the base-emitter junction of said transistor, the emitter junction of said transistor being further connected in circuit with said input winding section of said primary winding of said transformer such that current flowing through said transistor will energize said input winding section to induce a voltage in said secondary and in said feedback winding section, said input winding and said transistor being arranged in an oscillatory circuit, whereby as the current in said input winding section increases, said filament will limit the input current to said transistor, said filament being characterized as being a substantially constant current element over its operating range, thereby to control the output voltage of said transistor.

2. In an inverter ballast circuit for energizing a fluorescent lamp from a source of direct voltage with an oscillating circuit having an active element and controlled by an input current, the improvement comprising: transformer means including a primary winding and a secondary winding, said primary winding including an input winding section and a feedback winding section; means connecting said lamp between said secondary and said primary windings; and means connecting said feedback winding section, a filament of said

lamp and said active element in circuit such that the input current controlling said active element passes from said feedback winding through said filament, whereby as the magnitude of said voltage source increases, the current through said filament increases to substantially increase the resistance thereof, thereby to keep the input current to said active element substantially constant whereby a substantially constant voltage is applied and energizes said lamp independent of the magnitude of said voltage source over a given range.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,882,354 Dated May 6, 1975

Inventor(s) Randall L. May

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On page 1 of the printed matter, correct the assignee's name to:

The Coleman Company, Inc.

Signed and Sealed this

fifth Day of *August 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks